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A SPATIAL INTERNET PLATFORM FOR DELIVERING HIGH-END GOVERNMENT INFORMATION SERVICES

Abstract: This paper describes how database technology has evolved to deliver high-end performance and reliability necessary to support Front and Back Office operations like public service bureaus, call centers, dispatching services, and analysis activities. While early attempts to integrate generic GIS capability to existing IT framework has proven to be costly and unsustainable, new advances in database technology now enable users to manage all their spatial data in the database and make it accessible to a large range of business applications. I will describe how this *information-centric* approach to delivering high-end applications facilitates timely and cost-effective development, resulting lower management and training costs, reduced IT churn, and increased public satisfaction. The paper will highlight the emerging approach taken by the leading enterprise software vendors to deliver open, Internet-based platform for delivery of spatial services.

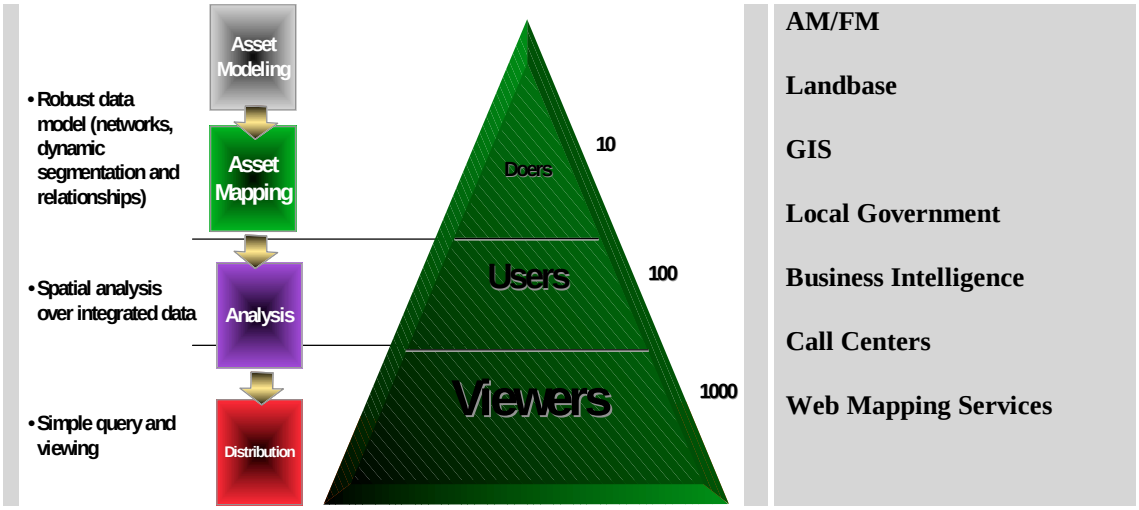
INTRODUCTION

Over the past decade, many government agencies have found that their GIS systems cannot be successfully integrated with their enterprise systems due to inherent design limitations. The result has been islands of spatial information and technology that undermine the organization's ability to add value to its information and technology investments. It has also led to increased training and development costs and the inability to share valuable information assets across the organization. Attempts to integrate applications – a GIS application and a customer care application, for instance – become difficult and expensive. Most importantly, these public organizations have not effectively leveraged their investments in the development of spatial information. However, the rich opportunity for making spatial data available to the broader corporate IT infrastructure lies with location-enabling common business applications. These include: customer care, business intelligence, supply chain, financial, and other application.

LOCATION ENHANCED BUSINESS APPLICATIONS

In the past four years the spatial information industry has undergone significant changes, evolving rapidly from a closed GIS-based niche application to an "open" enterprise application for disseminating location-enhanced business information. While the market for highly specialized GIS continues to grow at annual rates of 10 - 15%, there will be even faster growth for location-enabled capability within in mainstream business applications (call centers, data warehousing, customer relationship management, service delivery, e-commerce) (IDC 1999).

FIGURE 1: RELATIONSHIP BETWEEN APPLICATION CAPABILITY & SCALABILITY



Beginning in 1998, the market for spatial technologies (GIS, mapping, outside plant management) converged with enterprise applications and Internet technologies. Dataquest projects that the worldwide core software, and the software-related services segment of this market will reach approximately $2.5 billion by 2001. Of that amount, the market for cross-industry and vertical-specific customer relationship management (CRM) and analytical data warehousing applications will reach $1 billion by 2002 (IDC 1999). In specific industries, such as banking, as many as 53% of the end users are evaluating the use of spatial information in their data warehouses (IDC). These are the kinds of applications that government services are mandated to deliver.

Some detailed examples include:

- **Data warehousing/Business Intelligence** - analyzes all the transactions being collected in ERP systems (customer purchasing, sales, assets characteristics by time and place) to derive insight and enhance decision making.

- **Customer relationship management (CRM)-** enables organizations to understand, anticipate, and respond to their citizen needs, in a cost effective manner. Internet-centric business model using electronic storefronts and self-service to expand service delivery, shorten response time, improve efficiencies, and reduce costs for the fastest ROI.

- **E-commerce** - delivers a broad range of electronic business functions that exploit the Internet for the delivery of public services (automobile registration, parking ticket payment).

- **Supply Chain Management** - optimizes the flow of goods through the supply chain (product mix, inventory, distribution, warehousing, and shipment routes). Public procurement suppliers can directly review and take action on information that affects them.

SPATIAL ANALYSIS/DATA WAREHOUSING

Of the applications just described, two are expanding the use of Spatial technology with particular rapidity: Customer Care and Data warehousing. Organizations are looking to use their information and technological assets to reduce churn and increase customer loyalty. Today's hyper-competitive business environment demands that organizations anticipate and meet very high customer expectations for unique products and services. *Analytical* information systems that generate business intelligence about a community and its residents – who they are, where they live, their usage patterns, and their preference to kinds of services are fundamental to many public service mandates. For example, deregulated utilities are now expending large efforts to retain their customer base, while new start-ups aggressively market products and services to capture and capture new customers. In this environment, organizations must anticipate and meet very high customer expectations for unique products and services. Location-enhanced data warehousing provides the technology for supporting such analytical business functions. Some common decision support and analysis functions are listed in Table 1.

CUSTOMER RELATIONSHIP MANAGEMENT (CRM)

The explosive growth of the Internet has created an overwhelming amount of available information. Public agencies are under pressure to deliver a cohesive, "one stop shop" for citizens, who are demanding access to more information at convenient times and convenient places.

For example:

- Commuters can use the web to see the amount and location of traffic congestion and to choose alternative routes based on up-to-the-minute traffic reporting.
- Firefighters and police can rapidly dispatch vehicles to respond to emergency calls.
- Social service and health care officials can view client records and recommend local services based on proximity.
- Disabled, elderly, and public with special needs can access public telephony-centric call center services that provides the choice of how and when to interact for optimized customer care.

TABLE 1:
EXAMPLE OF GOVERNMENT DECISION SUPPORT AND CRM APPLICATIONS

Spatial Analysis/Data Warehousing	Customer Relationship Management
Targeted marketing	Public services response center
Network utilization	Citizen complaint center
Proximity analysis	Social services call center
Crime trend analysis	Public information kiosks
Community Planning analysis	On-line ordering and transaction capability
Service area analysis	On-line data collection (registration, census)
Siting Analysis	Notification of public works activities

Nearly all of the reporting and analysis activities noted in Table 1 have a spatial element: either a street address, a census block, a parcel number or some other location-based reference. This location dimension has significant potential for enhancing the level of analysis and public service allocation. For example, customer penetration and profitability can be spatially enabled through a simple map

graphic depicting clustered point data. Likewise, customer complaint analysis can be analyzed with a network infrastructure and network utilization to investigate whether reported service problems are resulting from localized infrastructure problems or temporal capacity constraints. These kinds of analysis and customer services form the bottom line of many organizations. They help segment a customer base and differentiate service delivery -- two key elements in increasing public service satisfaction and efficient management of public resources.

ORGANIZATIONAL BENEFITS

As mentioned earlier, embedding lightweight spatial capability into existing corporate applications holds tremendous potential. However, location-enhanced data warehouse and CRM applications must be able to leverage the underlying spatial capabilities of the leading database products, like Oracle Spatial. Examples of how DBMS-centric spatial technology increases operational efficiency while reducing cost include:

- **Low Cost of Ownership:** - applications can be deployed on a corporate Internet and accessing spatial data stored centrally, lowering ownership costs. This eliminates the need to install and maintain client-side software on the desktop and store and manage data separately, outside of the corporate database.

- **Low Risk:** – Spatial information can be integrated directly into the corporate DBMS. This results in scalable, secure, and high-performance applications. Customers can choose to deploy on any server platform (Unix, Linux, or NT) using existing IT resources to manage these applications.

- **High Value:** Larger numbers of users can access the application at virtually no additional costs to the organization. This means that all the users that need to access mission critical information can do so 24X365.

- **Return on Investment**: Decision makers increase public ROI by leveraging their previous investments in spatial and non-spatial information systems. Better information increases the likelihood of making sustainable siting decisions that draw from multiple departmental sources.

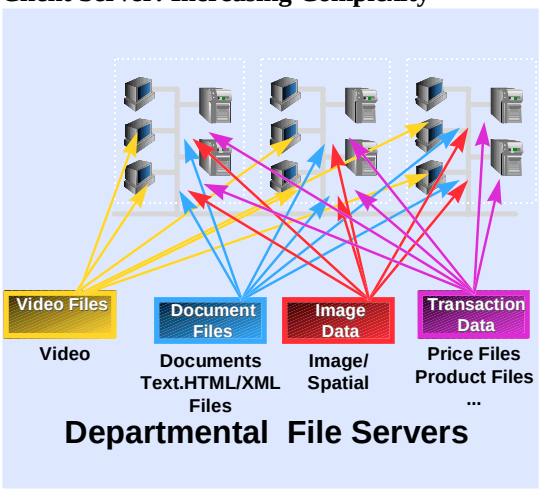
- **Increased Usability**: There is the perception that spatial systems like GIS are complex and difficult to use. While this was true in the past, the emergence of the Web has provided an intuitive client interface for simplifying spatial analysis. The web provides a delivery mechanism for integrating spatial information with business information.

All these advantages are driving forces for the creation of a new class of location enhanced business applications that help to integrate silos of information using a common database infrastructure.

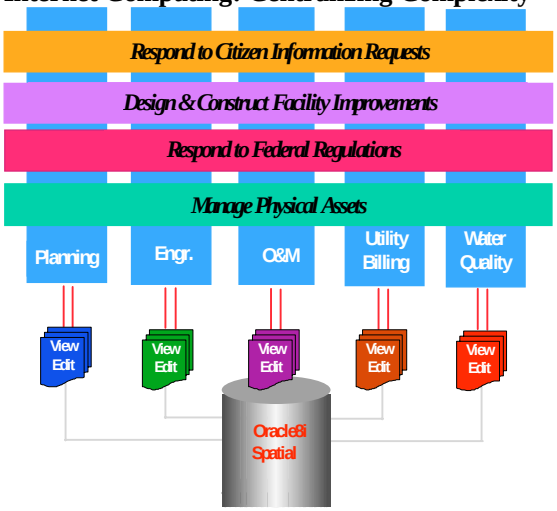
Public mandates and public service activities impose unique challenges to public institutions. Responding to citizen requests, designing public facilities, and managing public assets all require government departments to cooperate and exchange data. In the past, client server architectures empowered departmental computing needs at the cost corporate-wide information requirements. The result was the distribution of complexity, imposing unsustainable IT management burdens on local departmental IT personnel (Figure 2). With today's Internet Computing Platform led by vendors like Oracle, these information management can now be centralized. Information resources can be managed centrally by small group of experts while enabling users to view and edit information using simple Web browsers. Since public departments maintain different types of location-based information (street addresses, parcel numbers, road network, public assets) they will all benefit from the increased ability to standardize and share this information.

FIGURE 2: CLIENT SERVER V. INTERNET COMPUTING ARCHITECTURES

Client Server: Increasing Complexity



Internet Computing: Centralizing Complexity



INTERNET PLAFORM FOR LOCATION-BASED SERVICES

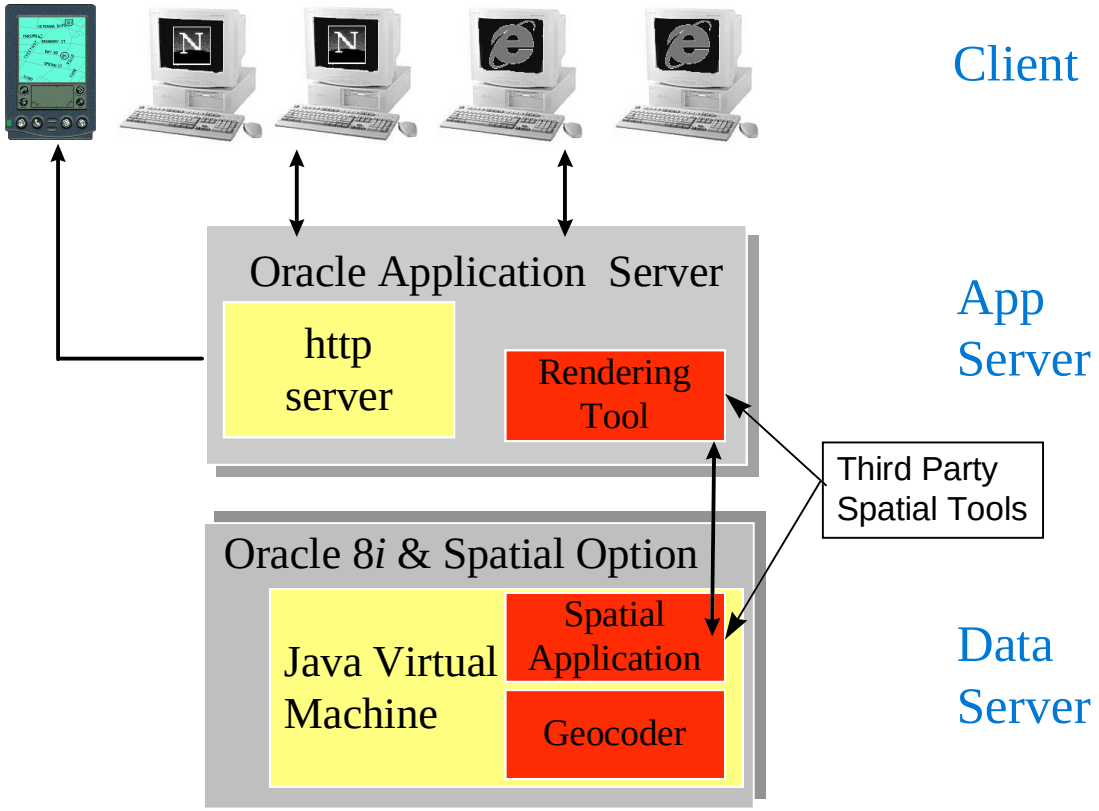
In an era of desktop and client server environments, each department maintained its own "island of spatial information" that was locally maintained and used for specific purposes. Hence, it is not uncommon for many agencies to maintain multiple mapping, engineering, and analysis which they cannot synchronize. However, the Internet is redefining the ways that spatial information is collected, managed, queried and disseminated. In this new Internet computing environment, spatial information assets can now reside on large servers that are professionally managed and accessed through a network via a browser, just like other data assets. A smaller numbers of large servers are used to consolidate databases, resulting in lower costs, improved reliability, heightened security, and dramatic improvement in quality of information.

By adhering to emerging industry standards such as OpenGIS, ISO-TC211, and SQL-MM, it is now possible to have multiple client tools access this information. It is no longer necessary to force all departments to standardize their tools and applications. Instead, what is standardized is the underlying data model. For example, using a Java Bean visualization component it is possible to embed mapping capability into standard government financial applications. By storing all spatial data in an open, OGC conformant schema, such as used by Oracle Spatial, it is possible to use simple web browsers to access mapping in the Planning department, engineering data in the Public Works department, and housing value data in the assessor's office. The ability to centralize all your spatial information assets in a common IT environment enables government to leverage its investments in spatial data – much like it has with other types of corporate information. In short, spatial data simply becomes another type of data that is stored in a standard relational database.

SPATIAL INTERNET PLATFORM ON ORACLE8*i*

In the past, databases were simply used as repositories of digital data, performing basic indexing and querying functions. Vendors delivered to hybrid GIS and image processing systems whose legacy of proprietary file formats continues to this day. However, database technology has rapidly evolved. Databases have now become platforms for deploying enterprise applications like e-commerce, CRM, digital libraries to hundreds and thousands of customers – all on the Internet. As one example, Oracle has introduced Oracle8*i*, a database platform for developing and deploying Internet and location-enabled business applications and services. It builds upon database technology that is open, scalable, secure, and extensible. With native support spatial data, there is no longer any need for spatial middle-ware or file-based systems. Oracle8*i*'s JServer, a Java Virtual Machine (JVM) embedded into the database kernel, enables third party Enterprise Java Beans (EJBs) to be hosted *inside* the database. This means that spatial applications can now runs inside the same address space as the server, utilizing server-based memory cache, eliminating context switching overhead, and reducing network traffic. The result is the unprecedented performance of third party spatial tools, geocoders, map renderers running inside the database. In the forthcoming release, a native Java compiler will be included in the server. This means that Java code will run as machine code, not as interpreted code – another significant performance improvement.

FIGURE 3. SPATIAL INTERNET PLATFORM ON ORACLE8*I*



With the availability of JVMs at all tiers of an IT architecture (data server, middle tier, client), permits spatial tools and applications to be packaged as EJB components plugging into any tier using native Java Database Connectivity (JDBC). For example in the Figure 3 above, a third party spatial tool and geocoder are embedded into the JServer. The map rendering component is embedded into the middle-tier, using the application server to push out compressed raster or live vector rendering operations to a thin client. The thin client (web browser) invokes processes that are intelligently carried at the middle and server tiers – increasing performance, optimizing processing, and

minimizing the amount of data transmitted along a network. This n-tier architecture builds on SQL, CORBA, XML, and Java – all open standards redefining the new paradigm for Internet computing.

CONCLUSION

New Internet based IT technology can empower organizations with unique capability to make timely and accurate decisions about any aspect of public business, whether its about a unique organizational decision regarding a specific issue or function, or a decision that has a location dimension. New Internet based, location-enhanced business intelligence tools and customer care applications allow public agencies to streamline their resource functions and empower employees to manage in a Web-based environment..

With the advent of spatially capability from the leading database vendors, the era of managing spatial data in hybrid systems or files based systems has come to a close. Storing spatial data in an enterprise-class server enables GIS, CAD, AM/FM applications to leverage advanced database features like: parallel query, replication, partitioning, security, scalability, none of which are supported in file-based or hybrid middle-ware systems. Second, spatial data is now stored in an open format, using rows and columns or arrays as opposed binary elements optimized for vendor specific applications. Third, spatial data can be managed, queried, and displayed using SQL from any enterprise application like financial, data warehouse, supply chain, CRM, and industry standard reporting tools. Finally, centralizing management reduces the overhead of managing different systems, eliminates training on different applications, and minimizes application integration costs. This means that public organizations can maximize the utilization of public resources, a necessary competitive tools in the public sector today and in the future

REFERENCES

IDC, 1999. "Report: Spatial Information Management: 1999 Worldwide Markets and Trends" June 1999. International Data Corp. Framingham, MA.